

Application of the Progressive Wavelet Correlation for Image Recognition and Retrieval

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Abstract: An algorithm for recognition and retrieval of image from image collection is developed. Basis of the algorithm is the progressive wavelet correlation. The final result is the recognition and retrieval of the wanted image, if it is in the image collection. Instructions for the choice of correlation threshold value for obtaining desired results are defined. The areas where the algorithm can be applied are also discussed. To increase efficiency is presented two phases solution. The first phase uses well-known methods of image retrieving by descriptors based on the content of the searched image. In the second phase the progressive wavelet correlation method is applied on the small number of image candidates selected in previous phase. Experiments are performed with data bases of 1000 and 10 000 images, using Oracle data base and the Matlab component Database Toolbox for operations with data bases. The algorithm is applicable to different formats of images.

Key words:

discrete cosine transform, image recognition, image retrieving, multiresolution, progressive wavelet correlation, wavelets.

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Bibliography

- [1] *A Review of Image Search Engines*, Technical Advisory Service for Images, 2006.
- [2] S. D. Babacan, X. Yin, A. C. Larson, and A. K. Katsaggelos, "Combination of MR Surface Coil Images Using Weighted Constrained Least Squares", In *IEEE Int. Conf. Image Process. 2008*, San Diego, CA, October 2008.
- [3] A. Bovik, *The essential guide to the image processing*, Academic Press, 2009.
- [4] V. Castelli *et al.*, "Progressive classification in the compressed domain for large EOS satellite databases," *Proc. ICASSP '96*, vol. 4, pp. 2199–2202, Apr. 1996.
- [5] S. Chaudhuri, editor, *Super-Resolution Imaging*, Kluwer Academic Publishers, New York, 2001.
- [6] *Database Toolbox User's Guide*, The Math Works, Inc., Natick, MA, 2005.
- [7] J. P. Eakins (1996) "Automatic image content retrieval – are we getting anywhere?" *Proceedings of Third International Conference on Electronic Library and Visual Information Research (ELVIRA3)*, De Montfort University, Milton Keynes, pp 123-135.
- [8] P. Enser, Y. Kompatsiaris, N. E. O'Connor, A. F. Smeaton, A. W. M. Smeulders, *Image and Video Retrieval*, Springer, 2004.
- [9] A. M. Eskicioglu and P. S. Fisher, "Image Quality Measures and Their Performance," *IEEE Transactions on Communications*, vol. 43, pp. 2959-2965, Dec. 1995.
- [10] M. Flickner *et al.*, "Query by image and video content: The QBIC system," *IEEE Comp.*, vol. 28, pp. 23-32, Sept. 1995.
- [11] R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, 2nd Edition, Prentice-Hall, 2002.
- [12] R. C. Gonzalez, R. E. Woods, S. L. Eddins, *Digital Image Processing Using MATLAB*, Prentice-Hall, 2003.

- [13] V. N. Gudivada and V. V. Raghavan (1995a) "Content-based image retrieval systems" *IEEE Computer* 28(9), 18-22.
- [14] A. Gupta et al (1996) "The Virage image search engine: an open framework for image management" in *Storage and Retrieval for Image and Video Databases IV*, Proc SPIE 2670, pp 76-87.
- [15] T. Hermes et al (1995) "Image retrieval for information systems" in *Storage and Retrieval for Image and Video Databases III* (Niblack, W R and Jain, R C, eds), Proc SPIE 2420, 394-405.
- [16] R. Holowczak, Baruch College City Univeristy, F. Artigas, Rutgers University, S.A. Chun, Rutgers University, J.S. Cho, Rutgers University and H.S. Stone, NECI, "An Experimental Study on Content-Based Image Classification for Satellite Image Databases", *IEEE Transactions on Geoscience and Remote Sensing* 40(6):1338-1347, 2002.
- [17] T. Huang et al (1997) "Multimedia Analysis and Retrieval System (MARS) project" in *Digital Image Access and Retrieval: 1996 Clinic on Library Applications of Data Processing* (Heidorn, P B and Sandore, B, eds), 101-117. Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign.
- [18] *Image Processing Toolbox User's Guide*, The Math Works, Inc., Natick, MA, 2009.
- [19] E. Izquierdo, *State of the art in content-based analysis, indexing and retrieval*, Public deliverable D2.1_V2, IST SCHEMA project, www.schema-ist.org, 2003.
- [20] C. E. Jacobs et al (1995) "Fast Multiresolution Image Querying" *Proceedings of SIGGRAPH 95, Los Angeles, CA* (ACM SIGGRAPH Annual Conference Series, 1995), 277-286.
- [21] A. K. Jain, "Advances in mathematical models for image processing", *Proc. IEEE*, 69(5):502-528, 1981.
- [22] R. Jain (1993) "Workshop report: NSF Workshop on Visual Information Management Systems" in *Storage and Retrieval for Image and Video*

- Databases* (Niblack, W R and Jain, R C, eds), Proc SPIE 1908, 198-218.
- [23] F. Jeng and J. W. Woods, "Compound Gauss-Markov random fields for image estimation", *IEEE Trans. Signal Process.*, 39:683–697, 1991.
- [24] T. Kato (1992) "Database architecture for content-based image retrieval" in *Image Storage and Retrieval Systems* (Jambardino, A A and Niblack, W R , eds), Proc SPIE 1662, 112-123.
- [25] J. Le Moigne, "Parallel registration of multi-sensor remotely sensed imagery using wavelet coefficients," *Proc. SPIE O/E Aerospace Sensing, Wavelet Appl.*, pp. 432–43, Apr. 1994.
- [26] J. S. Lim, *Two-Dimensional Signal and Image Processing*, Englewood Cliffs, N.J., Prentice-Hall, 1990.
- [27] W. Y. Ma and B. S. Manjunath (1997) "Netra: a toolbox for navigating large image databases" *Proc IEEE International Conference on Image Processing (ICIP97)*, 1, 568-571.
- [28] *MATLAB External Interfaces*, The Math Works, Inc., Natick, MA, 2005.
- [29] *MATLAB Getting Started with MATLAB*, The Math Works, Inc., Natick, MA, 2005.
- [30] *MATLAB Web Server User's Guide*, The Math Works, Inc., Natick, MA, 2005.
- [31] T. Minka (1996) "An image database browser that learns from user interaction" MIT Media Laboratory Technical Report #365.
- [32] R. Molina, J. Abad, M. Vega, and A. K. Katsaggelos, "Parameter estimation in Bayesian high resolution image reconstruction with multi sensors", *IEEE Trans. Image Process.*, 12(12):1642–1654, 2003.
- [33] *Multimedia Systems and Content-Based Image Retrieval*, Sagarmay Deb, University of Southern Queensland, Australia, 2004.
- [34] C. Nastar et al (1998) "Surfimage: a flexible content-based image retrieval system" presented at *ACM Multimedia '98*, Bristol, UK.
- [35] W. Niblack et al (1998) "Updates to the QBIC system" in *Storage and Retrieval for Image and Video Databases VI* (Sethi, I K and Jain, R C, eds), Proc SPIE 3312, 150-161.

- [36] Oracle Database Application Developer's Guide - Large Objects, 10g Release 1 (10.1), 2003.
- [37] Oracle Database JDBC Developer's Guide and Reference, 10g Release 1 (10.1), 2003.
- [38] Oracle *interMedia* User's Guide, 10g Release 1 (10.1), 2003.
- [39] A. Pentland et al (1996) "Photobook: tools for content-based manipulation of image databases" *International Journal of Computer Vision* **18**(3), 233-254.
- [40] F. Rabbitti and P. Stanchev (1989) "GRIM_DBMS: a graphical image database management system" in *Visual Database Systems* (Kunii, T, ed), Elsevier, Amsterdam, 415-430.
- [41] Y. Rui et al (1997) "Relevance feedback techniques in interactive content-based image retrieval" in *Storage and Retrieval for Image and Video Databases VI* (Sethi, I K and Jain, R C, eds), Proc SPIE 3312, 25-36.
- [42] S. Sclaroff, L. Taycher, and M. La Cascia, "Imagerover: A content-based image browser for the world wide web," *IEEE Wksp. Content-Based Access of Image and Video Libraries*, pp. 2-9, June 1997.
- [43] J. L. Semmlow, *Biosignal and Medical Image Processing: MATLAB-Based Applications*, CRC, 2004.
- [44] *Signal Processing Toolbox User's Guide*, The Math Works, Inc., Natick, MA, 2005.
- [45] E. Silva, K. A. Panetta, S. S. Agaian, "Quantify similarity with measurement of enhancement by entropy," Proceedings: *Mobile Multimedia/Image Processing for Security Applications*, SPIE Security Symposium 2007, Vol. 6579, Paper #6579-0U, Orlando, FL, April 2007.
- [46] J. R. Smith and S. F. Chang (1997a) "Querying by color regions using the VisualSEEK content-based visual query system" *Intelligent Multimedia Information Retrieval* (Maybury, M T, ed). AAAI Press, Menlo Park, CA, 23-41.

- [47] J. R. Smith and S. F. Chang (1997b) "An image and video search engine for the World-Wide Web" in *Storage and Retrieval for Image and Video Databases V* (Sethi, I K and Jain, R C, eds), Proc SPIE 3022, 84-95.
- [48] H. Stark and J. W. Woods, *Probability, Random Processes, and Estimation Theory for Engineers*. Prentice Hall, Upper Saddle River, NJ, 1986.
- [49] I. Stojanovic, M. Bogdanov, "Location of Objects in a JPEG Image with Progressive Wavelet Correlation using Fourier methods", *9th Telecommunications Forum*, pp. 561-564, Belgrade, Yugoslavia, Nov. 20-22, 2001.
- [50] I. Stojanovic, M. Bogdanov, D. Taskovski, "Pixel-Based Searching for Object Location in a JPEG Image", *MELECON 2002-11th Mediterranean Electrotechnical Conference*, on CD-ROM, Cairo, Egypt, May 7-9, 2002.
- [51] I. Stojanovic, D. Taskovski, I. Kraljevski, "Normalized Correlation Coefficients for Searching JPEG Images", *7th IT' 02*, pp. 104-107, Zabljak, Yugoslavia, 24 Feb. - 2 Mar., 2002.
- [52] I. Stojanovic, M. Bogdanov, "Pixel-Based Searching of Images Stored in a Database", *ICEST2006*, pp. 165-168, Sofia, Bulgaria, 29 June – 1 July 2006.
- [53] I. Stojanovic, M. Bogdanov, S. Bogdanova "Searching of images stored in a database using content and pixel based methods", *14th Telecommunications Forum*, pp. 486-489, Belgrade, Yugoslavia, Nov. 21-23, 2006.
- [54] I. Stojanovic, S. Bogdanova and M. Bogdanov, "Content-Based Image Retrieving Improved by Pixel-Based Search", *14th IWSSIP 2007 and 6th EC-SIPMCS 2007*, pp. 395-398, Slovenia, Maribor, 27-30 June, 2007.
- [55] I. Stojanovic, S. Bogdanova and M. Bogdanov, "Retrieving Images Using Content-Based Search and Progressive Wavelet Correlation", *ICEST2008*, pp. 121-124, Nis, Serbia, June 25-27, 2008.

- [56] I. Stojanovic, S. Bogdanova and M. Bogdanov, "Retrieving Images Using Content-Based Followed by Pixel-Based Search", *15th International Conference on Systems, Signals and Image Processing*, pp. 271-274, Bratislava, Slovak Republic, June 25–28, 2008.
- [57] I. Stojanovic, S. Bogdanova and M. Bogdanov, "Our experience with image retrieval using progressive wavelet correlation", *17th Telecommunications Forum*, pp. 944-947, Belgrade, Serbia, Nov. 24-26, 2009.
- [58] I. Stojanovic, S. Bogdanova, M. Bogdanov, and D. Taskovski, "Performance of the Progressive Wavelet Correlation for Image Retrieval", *World Academy of Science, Engineering and Technology*, ISSN: 2070-3724, pp. 33-37, Issue 64, April 2010.
- [59] I. Stojanovic, S. Bogdanova, M. Bogdanov, and I. Kraljevski, "Performance of the Hybrid Method of Image Retrieval", *ICEST2010*, pp. 199-202, Ohrid, Macedonia, June 23-26, 2010.
- [60] I. Stojanovic, S. Bogdanova, M. Bogdanov, "Application of the Progressive Wavelet Correlation in Image Retrieving", *Journal of Computer Science and Control Systems (JCSCS)*, ISSN 1844-6043, pp. 77-82, Vol. 3, Nr. 2, 2010.
- [61] I. Stojanovic, S. Bogdanova, M. Bogdanov, "Applying of the Combination of Content-Based Search and Progressive Wavelet Correlation in Image Retrieving", *Journal of Computer Science and Control Systems (JCSCS)*, ISSN 1844-6043, pp. 83-85, Vol. 3, Nr. 2, 2010.
- [62] I. Stojanovic, S. Bogdanova and M. Bogdanov, "Application of Non-Iterative Method in Digital Image Restoration", *18th International Conference on Systems, Signals and Image Processing*, pp. 235-238, Sarajevo, Bosnia and Herzegovina, June 16–18, 2011.
- [63] H. S. Stone, "Image Libraries and the Internet," *IEEE Commun. Magazine*, pp. 99-106, Jan. 1999.
- [64] H. S. Stone, "Progressive Wavelet Correlation Using Fourier Methods," *IEEE Trans. Signal Processing*, vol. 47, pp. 97-107, Jan. 1999.

- [65] H. S. Stone and T. Shamoan, "The use of image content to control image retrieval and image processing," *Int'l. J. Digital Libraries*, vol. 1, no. 4, pp. 329–43, Dec. 1997.
- [66] H. S. Stone and R. Wolpov, "Blind Cross-Spectral Image Registration Using Prefiltering and Fourier-Based Translation Detection", *IEEE Transactions on Geoscience and Remote Sensing* 40(3):637-650, 2002.
- [67] H.S. Stone, E.C. Chang, and S.A. Martucci, "A Fast Direct Fourier-Based Algorithm for Subpixel Registration of Images", *IEEE Transactions on Geoscience and Remote Sensing* 39(10):2235-2243, 2001.
- [68] H.S. Stone, J. Le Moigne, and M. McGuire, "The Translation Sensitivity of Wavelet-Based Registration", *IEEE Transactions on Pattern Analysis and Machine Intelligence* 21(10):1074-1081, 1999.
- [69] G. Strang and T. Nguyen, *Wavelets and Filter Banks*, Wellesley-Cambridge Press, 1996.
- [70] I. E. Sutherland. *SKETCHPAD: A Man-Machine Graphical Communication System*. PhD thesis, MIT, 1963.
- [71] A. M. Tekalp, H. Kaufman, and J. W. Woods, "Identification of image and blur parameters for the restoration of non-causal blurs", *IEEE Trans. Acoust.*, 34:963–972, 1986.
- [72] P. P. Vaidyanathan, "Orthonormal and biorthonormal filter banks as convolvers, and convolutional coding gain," *IEEE Trans. Signal Processing*, vol. 41, pp. 2110-2130, June 1993.
- [73] P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Englewood Cliffs, N.J., Prentice-Hall, 1993.
- [74] G. K. Wallace, "The JPEG still-picture compression standard," *Commun. ACM*, vol. 34, no. 4, pp. 30-44, Apr. 1991.
- [75] *Wavelet Processing Toolbox User's Guide*, The Math Works, Inc., Natick, MA, 2005.
- [76] J. W. Woods and V. K. Ingle, "Kalman filtering in two-dimensions – further results", *IEEE Trans. Acoust.*, 29:188–197, 1981.